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WATER INSECTS FROM A PORTION OF THE SOUTHERN UTAH DESERT.....*R. C. Moore and H. B. Hungerford.*

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Water Insects from a Portion of the Southern Utah Desert.

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INTRODUCTION.

THE COLORADO PLATEAU.

Not the least interesting of that well-known and yet little known country of varied attractions, the Great Western Cordillera of America, is the region of lofty plateaus, towering cliffs and deep, impassable canyons which is known as the Colorado plateau. Bordered on the east by the snow-clad peaks of the Rocky Mountains, on the north by the Uinta mountains, and on the west and south by low-lying deserts of the Great Basin and the lower Colorado valley, the Colorado plateau includes most of western Colorado, eastern and southern Utah, northern Arizona and northwestern New Mexico. Unlike the serrated peaks, irregular jagged spurs and sharp-topped divides of the Rockies, or of the mountain ranges in the Great Basin and Arizona deserts, the plateau country is a land of elevated, essentially flat-topped tables, which are terminated for the most part in steep, irregularly trending cliffs, and of great canyons which, converging on and culminating in the world-famous canyon of Colorado river, ramify almost every section of the plateau province. The tablelands are formed by hard rock formations which lie in more or less nearly horizontal positions, and the steep cliffs which border the plateaus or wall in the canyons mark the edges of these hard formations. Exceptions to the general architectural scheme of the Colorado plateau country are a few small mountain masses of igneous origin, volcanic cones like the San Fran-

cisco mountains in Arizona, or laccolithic intrusions like the Henry mountains in southern Utah. These are not important in the aggregate, but are striking on account of contrast.

All of the Colorado plateau region is arid or semiarid. There is little rain, and most of that which does come falls during a small part of the year and in torrential showers. Much of the characteristic topography and the aspect of the country in general is due chiefly to this.

THE HIGH PLATEAUS OF SOUTHERN UTAH.

The features and the conditions which are broadly typical of the Colorado plateau as a whole find especially characteristic expression, and, indeed, culminate in the south central part of Utah and adjacent portion of Arizona. From the Grand canyon of Colorado river, the most profound and prodigious of the canyons, the stratified rock platforms rise tier on tier like gigantic stairs ascending northward. The top "stairs," in southern Utah, have an elevation of more than 10,000 feet above sea level, and comprise the so-called high plateaus. It is almost inevitable that this lofty plateau country, so closely adjacent to the deepest of the canyons, should be intricately dissected by tributary canyons. The high plateaus and adjoining region may therefore be specially designated as the "canyon lands." Travel is by tortuous and extremely toilsome routes, now in the depths of a profound abyss, now crossing a plateau spur of mountainous proportions. Some areas are absolutely inaccessible, and large districts are almost unexplored. Population is confined to a very few of the accessible valleys where irrigation permits cultivation of a little of the land adjacent to the water supply. Aside from these outposts of determined agricultural skill and industry, the region is traversed only by occasional cattlemen, prospectors or explorers.

CLIMATE.

The two main features which characterize the climate of southern Utah and affect more or less directly the life of the region, as well as physiographic processes, are dryness and temperature variation. In part of the area rainfall is less than five inches in the year, and in all of it the average is less than ten inches per year. In general, there is most rain in the three summer months, July August and September; and least rain in the spring months, April, May and June. The fall and winter months have an intermediate rainfall. The effect of the dry spring season, when most plants begin to develop rapidly and when many of the animals, especially the insects, pro-

gress swiftly through early life stages toward the vigor of mid-summer maturity, is to retard or to inhibit the development of life. Seeds may germinate, but, without rains, growth lags or ceases. Larvæ of insects, polliwogs, and whatever animal life is dependent on waters, are restricted to permanent pools, springs or streams, for there are no temporary breeding waters in the dryness of the spring. The distribution of the yearly precipitation at four stations in the vicinity of the localities described in this paper, is shown in chart on page 412.

The temperature of the plateaus is influenced to a large extent by the clear, dry atmosphere and by the altitude. During the days the sun warms the air and the ground, and the bare rocks reflect the heat rays back into the air. At night radiation is rapid and the temperature quickly falls. This large diurnal range in temperature is characteristic of arid or semiarid regions. At Tropic, in central western Garfield county, a freezing temperature in each of the twelve months has been reported, while the maximum temperature is greater than 100 degrees. (See chart, page 413.)

AVERAGE MONTHLY AND ANNUAL PRECIPITATION, IN INCHES, AT UNITED STATES WEATHER BUREAU IN REGION OF THE COLLECTIONS.

STATION.	County.	Elev.	Years.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Escalante.....	Garfield.....	5,700	1901-'18	1.34	1.01	1.14	0.50	0.45	0.50	1.66	1.71	1.07	1.12	0.47	0.72	11.69
Hite.....	Garfield.....	3,000	1902-'14	.66	.68	.70	.36	.50	.31	.49	.63	.73	.75	.78	.69	7.28
Tropic.....	Garfield.....	7,000	1897-'18	1.17	1.05	.90	.71	.63	.37	1.47	1.51	1.20	.78	.79	1.00	11.58
Kanab.....	Kane.....	4,925	1903-'17	1.82	1.39	1.72	1.19	.66	.26	1.30	.77	.79	.87	1.28	.78	12.83

HIGHEST AND LOWEST TEMPERATURES, FAHRENHEIT.

STATION.	County.	Elev.	Years.	Jan.		Feb.		Mar.		April.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Annual.	
				H.	L.	H.	L.	H.	L.	H.	L.	H.	L.	H.	L.	H.	L.	H.	L.	H.	L.	H.	L.	H.	L.	H.	L.	H.	L.
Escalante.....	Garfield.....	5,700	13	-61	-17	84	-11	80	10	83	13	92	25	98	31	98	38	97	32	90	22	87	16	72	1	62	-15	98	-17
Hite.....	Garfield.....	3,000	14	66	1	81	6	86	18	94	28	104	35	111	40	115	44	110	51	104	39	91	29	76	19	76	-1	115	-1
Tropic.....	Garfield.....	7,000	20	67	-2	67	-32	74	0	84	6	96	13	100	20	101	32	101	30	100	11	84	10	72	-9	76	-15	101	-32
Kanab.....	Kane.....	4,925	9	62	-15	70	-8	85	1	87	8	101	16	101	23	105	39	101	35	95	24	89	9	79	10	66	-11	105	-15

SURFACE WATERS.

Though the topography of southern Utah is very evidently the result chiefly of erosion by running water, there are few perennial streams in the region. The Colorado, master stream of the plateau country, gathers the waters from the west slopes of the Rockies, from the Uintas and other ranges where rains and melting snows furnish a varying but unending water supply. The tributaries which unite to form the Colorado begin, for the most part, as clear mountain streams, but in southern Utah the river carries so heavy a load of mud and sand that the water is dark reddish brown. On this account the name Colorado was first applied. The river is large and swift, with swirling eddies and numerous rapids. The only permanent tributaries to the Colorado in southern Utah are San Juan river on the south and Dirty Devil and Escalante rivers on the north. Each of these streams flows in a deep canyon, and, except for size, is essentially similar to the Colorado. The Escalante, which is the main stream in the region from which most of the collections of insects were obtained, is fed by the melting snows, rains and springs of the southern extremity of the highest of the plateaus, the Aquarius. Its waters are somewhat clearer than those of the other streams, because most of its course lies through massive sandstones.

The numerous smaller streams in southern Utah contain water only at times of local rainfall. The run-off is very rapid, and after a torrential, muddy flood of less than an hour, or at most a few hours, the flow ceases. This type of swift, intermittent streams is characteristic of all the plateau region.

After rains there are in places pools or "tanks" in such natural hollows as may retain any of the water. Some of these are found in the stream channels, others in eroded depressions in the naked rock. Some are small, shallow and short-lived under the rays of an intense sun and a thirsty atmosphere; others are larger, and occasionally deep. Those in the channels of streams commonly contain very muddy water, which, because of the excessive fineness of the mud, retains the sediment in suspension until evaporation gradually gives it the consistency of thick soup or gravy, and finally of brick. Where the rain water accumulates in sandstone, or where the gathering waters do not cross exposures of the soft shales which furnish most of the muds, the waters remain fairly clear. The larger "tanks" may retain water from year to year, shrinking slowly through times of drought, but refilling on the

coming of rain. These little pools of moderately clear water afford sanctuary for such water-breeding or water-living animals as inhabit the region, and in some cases it is a populous and assorted community that crowds together.

Springs may be mentioned among the surface waters of southern Utah, although they are not numerous, and the water from them very shortly sinks into the ground. They are in many cases nearly permanent, and are an important source of supply, especially as regards the uses of man. None of the springs or seepages in the plateau region studied has a flow of more than a few gallons an hour.

It is frequently a number of miles from one spring, "tank" or other permanent water source to another.

FIELD WORK.

In the summer of 1921 and 1922, Mr. Moore, with a party of four assistants, was assigned by the United States Geological Survey to make an examination of a portion of the high plateaus of southern Utah, with reference to coal resources and possibilities of oil and gas development. A detailed geological map of approximately 3,000 square miles was made, and reconnoissance study of a very much larger area was completed. The region mapped comprises most of central eastern Garfield county, a portion of central Wayne county, and eastern Kane county, Utah. Although the primary purpose of this work had to do with possible coal, oil and gas resources, special attention was given to water supply, for the region is a semidesert. Not only was it important for the party to find water for camp purposes, but the possible development of water supply is in all cases the most important consideration in the utilization of such a region. During the course of this work, wherever water insects were found, and where it was possible without interruption of the main objects of the work, collections were made. Since no other similar collections have been reported from this region, and since the distribution of water insects in this region is both of biological and general entomological interest, the results are here presented. Identification and special notes on the species found are the work of Mr. Hungerford.

DESCRIPTION OF COLLECTIONS.

Since the collections of water insects to be noted below were gathered as opportunity offered and not as a part of a systematic faunal survey, the data are perhaps somewhat fragmentary and scattered. However, since the sources of water supply in such

country are not numerous, and since it is necessary for the traveler, whatever his mission, to seek the places where water may be had, it is probable that a considerable number of the places where water insects might occur were observed. In each of these a collection, representing as far as possible all of the species present, was obtained. The collections include mainly those from springs and "tanks." It is possible that water insects could have been found in some of the seepages along streams or in the permanent streams, but there was no opportunity to make special search for these.

SMALL "TANK," ONE AND ONE-HALF MILES ABOVE MOUTH OF MULEY TWIST CREEK, EASTERN GARFIELD COUNTY, UTAH.

Muley Twist creek is an intermittent stream whose bed is dry the greater part of the year. It occupies a very deep box canyon, carved in massive red and yellow sandstone. About seventy-five feet above the bottom of the canyon, on its sloping west sandstone wall, was found at one point about one and one-half miles above the mouth of the creek, a little "tank" about one by two feet in width and length and with greatest depth of approximately one foot. The depression was filled with clear water, part probably caught in a recent rain and part derived from a very small seep in the sandstone above. The "tank" is probably not at all permanent. It was surrounded by bare smooth sandstone, without any near-by plant growth.

In this little basin lived a group of seven individuals of *Arctocorixa abdominalis* Say, without other insect life.

"TANK" ABOUT TWO MILES ABOVE MOUTH OF MULEY TWIST CREEK, EASTERN GARFIELD COUNTY, UTAH.

On the east side of the Circle Cliffs and along the Water Pocket Fold in eastern Garfield county are a number of "tanks" which contain water in all but the driest seasons. From one of these, in the bed of Muley Twist creek, beneath a high sandstone cliff, a number of water bugs were taken. The pool was about eight feet in diameter and three feet deep in one part at the time of our visit in August. Two or three large cottonwoods shade the pool, but there is almost no other vegetation near at hand.

In this little basin was taken one dytiscid beetle, *Rhantus binotatus* Harr., and upon the surface eight specimens of *Gerris orba* Stal, all winged, and one pair mating (five males and three females). The solitary dytiscid beetle appears to be a new record for Utah. Its previous capture has been recorded for Wisconsin and Arizona.

"TANK" ON COLORADO RIVER AT WATER POCKET FOLD, KANE COUNTY.

This was located on the north bank of the Colorado river near the mouth of a small tributary canyon at Bennett's oil camp, where Water Pocket Fold crosses the canyon of the Colorado river, about eight miles above the mouth of Escalante river, eastern Kane county. A pool of clear rain water filled the depression in bare sandstone, about four feet wide, five feet long and two and one-half feet deep; no vegetation around the pool; about thirty yards from Colorado river, a swift, muddy stream, very unlike the water in the "tank"; unknown distance to adjacent pools of clear quiet water; elevation about 3,500 feet. Here were taken:

Fifteen *Arctocorixa abdominalis* Say, four males, eight females and three nymphs. This represents the farthest north record for the species, which was described from Mexico and reported from Texas and California by Uhler.

One *Notonecta insulata* Kirby, female.

Two *Thermonectes marmoratus* Hope, one male and one female. The capture of this beautiful dytiscid appears to be a new record for the state. Leng's catalogue records it from Arizona and Lower California.

SPRING OPPOSITE OWL CAVE, HARRIS WASH, GARFIELD COUNTY, UTAH.

About twenty miles southeast of the little town of Escalante, eastern Garfield county, Utah, a permanent spring is found in the sandstone wall of Harris canyon, which is tributary to Escalante river. The flow of this spring is not large, but the water is of excellent quality, and, as natural shelter is conveniently near at hand in a large sandstone cavern, Owl Cave, the spot is a camping place for most of the few travelers who pass this way. The water from the spring irrigates naturally several square yards of protected ground adjacent to the spring. A beautiful little meadow, therefore, has been formed, through which the water flows a short distance before sinking into the sand.

This spring and short stream support a populous community of aquatic insects and other life. However, only two species of water bugs were observed, *Gerris remigis* Say and *Trepobates pictus* Uhl.

SPRING IN WATER POCKET FOLD, CIRCLE CLIFFS, GARFIELD COUNTY, UTAH.

One of the very few water sources in the northeastern side of the Circle Cliffs is a small spring, from which the water flows a few yards before disappearing in the floor of a canyon tributary to

Muley Twist creek. The adjacent rocks, chiefly sandstone, are nearly bare of vegetation, though not far distant are numerous piñon, scrub cedar and sagebrush. The spring varies somewhat in volume, but does not commonly dry up in the spring dry season.

On the surface of the spring and the little stream below are numerous representatives of the species *Trepobates pictus* and *Gerris remigis*. A large number of individuals of each were obtained, including a considerable number of nymphs belonging to the first species. The *Trepobates* were more numerous than the Gerrids at the time of observation in August, 1921—a rather unusual condition as compared with other localities inhabited by the two forms.

SPRING ON UPPER HENRIEVILLE CREEK, SOUTH CENTRAL GARFIELD COUNTY, UTAH.

An area of special scenic and geologic interest in southern Utah is Table Cliff and the surrounding very rough district in south central Garfield county. South of Table Cliff, on one of the branches of upper Henrieville creek, is a seepage of very alkaline water, the only source available for camp use in the head canyons under the cliff. The water is so strongly mineralized as to be hardly potable.

On the surface of the short, trickling stream below the seep several water bugs were taken. A few *Gerris remigis* Say and a considerable number of *Microvelia* are the inhabitants of this apparently inhospitable haven. The *Microvelia* species of this region has not been determined. It may be new.

"TANK" NEAR SOUTH POINT OF KAIPAROWITS PLATEAU, EASTERN KANE COUNTY, UTAH.

Most of the observed watering places in southeastern Utah did not contain water insects at the time of visit in the summer of 1922. Of four springs and pools on the top of Kaiparowits plateau, a high tableland which extends southeastward toward Colorado river from the uplands farther north, only one appeared to contain any aquatics. This was a partially rain-filled "tank" in the bottom of one of the narrow, steep-sided canyons which cut the plateau surface. The "tank" was carved in bare, massive sandstone, without near-by vegetation. The pool was about six feet long by one foot wide, and its maximum depth a little over one foot. In this pool were several *Notonecta insulata* Kirby, but no other water bugs.

LAST CHANCE CREEK, EASTERN KANE COUNTY, UTAH.

In a part of the sandstone canyon of Last Chance, about twenty-five miles above the point where it flows into Colorado river, a small stream flows more or less permanently. Other parts of the canyon contain intermittent flow, but in most cases, except for occasional groups of *Gerris remigis*, did not contain other observed water bugs. At the place described, a group of small dytiscids, a number of *Microvelia* and some gerrids were collected.

SPRING ON PARIA RIVER, ABOUT FIFTEEN MILES BELOW CANNONVILLE, KANE COUNTY, UTAH.

Most of the lower Paria river, the main stream in south central Kane county, Utah, is dry the greater part of the year. The river has carved a very deep sandstone canyon, which affords the only passageway from north to south across this part of the country. At a point about fifteen miles below the town of Cannonville, the last settlement on the southward route to Colorado river, at Lee's Ferry, about seventy-five miles distant, is a fine spring. The flow is fairly large, as compared with other springs in this country, and the water is clear and not alkaline.

A host of *Gerris remigis* and *Trepobates pictus* were found on the water of the spring.

LOWER ROCK CREEK, EASTERN KANE COUNTY, UTAH.

Water flows more or less permanently in the lower part of Rock creek, the easternmost of the longer, deep canyons tributary to Colorado river west of Kaiparowits plateau. The canyon of Rock creek, as the name perhaps suggests, is somewhat unusual, even among the great, bare rock cliffs and canyons of the plateau country. Its walls and bottom are mostly composed of naked rock, and sculpture by running water has produced an almost indescribably rough topography.

The stream at the camp site of the writer, about two miles above Colorado river, contained numerous *Microvelia* and a few gerrids. No other water bugs were observed.

NEAR GOODRIDGE, SAN JUAN COUNTY, UTAH.

In a small, isolated spring, about one foot in diameter and a few inches deep, were taken three *Notonecta insulata* Kirby. No other water insects were present. This tiny basin of water was three miles from the swift, muddy San Juan river, and there were no other near water sources known. The location of the spot is at the west side

of Comb Ridge, where the road from Bluff to Goodridge enters Comb Wash. Some vegetation was growing about the spring.

To the above Utah collections may be added this interesting one from northwestern Colorado, made in 1920.

JUNCTION MOUNTAIN, YAMPA RIVER, NORTHWESTERN COLORADO.

In the deep canyon of Yampa river, where the river plunges through Junction mountain, about thirty-five miles east of the confluence of the Yampa and the Green, in northwestern Colorado, were taken forty-four *Rhagovelia distincta* Champ., all apterous; nine were males, four nymphs, and the remainder females; also seven *Trepobatopsis trux* Bueno, two males and five females, described by Mr. Bueno as new.

From a small, sluggish stream at west side of Junction mountain were taken an interesting series of large gerrids. These vary in color from russet to the dark color typical of *Gerris remigis* Say. The russet-colored form has been determined by Mr. J. R. de la Torre Bueno as *Gerris orba* Stal. Of these there are nineteen specimens, nine males and ten females. Thirteen of the lot are apterous. *G. orba* Stal has been listed from California, Oregon and Nevada hitherto. The others, forty-seven of them, all apterous, are of a trifle lighter color than *G. remigis* Say, but obviously are the same as Bueno's *orba*.

In an attempt to find differences between our common *Gerris remigis* Say and this series from the West, all of the Kansas and Colorado material available (a series from the eastern margin of Kansas through the state and across Colorado) has been very carefully studied. The Kansas forms are darker and larger as a series, but it does not seem possible at the present time to fix upon any structural characters to distinguish these forms.

In connection with the problem of separating the striders, it may not be out of place to state that it seems to have been overlooked that *Gerris conformis* Uhl. males have the ventral side of the sixth abdominal segment singly emarginate, like *Limnoporus rufoscutellatus* Latr. Indeed, the two species have, in addition to the above genital character, another distinctive character that is common to both, namely, their very long legs. The hind femora in both species greatly surpass the tip of the abdomen. The examination of such material as has been available suggests that the two species commonly accepted as *L. rufoscutellatus* and *Gerris conformis* Uhl. may be separated as follows:

A. Antennal segment 1 longer than 2 plus 3. Eyes protuberant. Middle and hind femora about equal in length. Venter of sixth abdominal segment in male with median longitudinal fossa. The seventh with a longitudinal ventral carina. *Gerris conformis* Uhl.

AA. Antennal segment 1 shorter than 2 plus 3. Eyes not protuberant. Middle femora shorter than hind femora. Venter of sixth abdominal segment in male without fossa and seventh segment not carinate. *Limnoporus rufoscutellatus* Latr.

In addition it may be stated that *L. rufoscutellatus* Latr. is a more slender species, and that it is usually of a russet color. *Gerris conformis* Uhl. has the anterior part of the pronotum bearing two prominent papillæ and well-elevated callosities.

It would seem somewhat of a question whether these two species, having in common genital characters and exceptionally long femora, can be placed in separate genera upon the antennal character alone. Structurally they are more nearly congeneric than *G. remigis* Say and *G. conformis* Uhl. The latter belongs with *L. rufoscutellatus* Latr., and the generic characters of *Limnoporus* should be revised.

RÉSUMÉ.

In brief résumé of the above collecting notes, it may be said that the southern Utah desert affords extremely interesting problems for the student of water life. The light annual rainfall, the isolation of the pools and the nature of the water they contain, lend interest to the study of the resident population of the waters. The collections here reported represent the complete insect population of the various pools surveyed. One isolated little spring-fed pool, the size of a washbasin, contained three *Notonecta insulata* Kirby, and no other insects. Another little rain-filled "tank," less than two feet in diameter and a foot deep, located high up on the sloping wall of a canyon, contained seven water boatmen, *Arctocorixa abdominalis* Say, and not another insect. The scant annual rainfall of from five to ten inches, with the exceptionally light fall in April, May and June, works against a large population of aquatics. The water bugs thus utilize every available supply of water. The pools contained the corixids, notonectids and dytiscids, while the striders were found on the springs more commonly than upon the "tanks." The presence of winged species in places remote from permanent water is readily understood. The finding of eight *Gerris orba* Stal, all winged, upon a rain-filled "tank" and forty-seven specimens of the same species along the Yampa river, all apterous, is worthy of note.*

* An interesting note on the factor regulating wing development is suggested by collecting notes on *Microvelia macgregori* Kirk. in New Zealand by Mr. J. G. Myers, in the New Zealand Journal of Science and Technology, vol. V, pp. 6 and 7. He writes that his collections of this insect in the lowlands have been almost entirely apterous forms, while at an altitude of 4,500 feet every capture was winged.